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## (54) A PROCESS AND APPARATUS FOR STEAMING FABRICS

(71) We, ARIOLI & C. S.r.L., of Via Pietro Clerici, Gerenzano (Varese) Italy, an Italian Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process and apparatus for wet-heat treatment by steam of fabrics, more particularly textile web material.

It is known that after weaving, fabrics particularly of synthetic, natural or mixed fibers, require preparatory treatments prior to receiving colours used in dyeing and/or printing.

It is also known that synthetic, natural and mixed fabrics require additional treatments after weaving to improve their consistency or compactness. Such treatments are directed to shrinking the wefts and warps in order to impart a higher compactedness, volume and softness to the fabric.

It is further known that after various operations, referred to as e.g. textile improvings and finishings, the fabrics that, for example, had been creped or made bulky, require the return of their initial crepe or bulkiness characteristics, which have been modified as the fabrics pass through the various machines needed for the intermediate processing steps.

Such preparatory, additional or fabric characteristic returning treatments, are normally carried out in hot or cold water baths, or with hot air. However, such treatment is normally carried out with no control over the shrinkage of the fabric, making it impossible to maintain constant the final characteristics of the fabric after the imparted treatment. Further, equipment of substantial constructive complexity as well as large amounts of water and heat are required, with a resulting high consumption of power and labour. All of this results in relatively high processing times and corresponding increase in production costs.

It is an object of the present invention to provide a process and apparatus for bulkiness, shrinkage, crinkliness or relaxation treatments for fabrics of synthetic, natural, or mixed fibers by means of saturated or superheated steam, which minimizes or avoids part or all of the above mentioned disadvantages. Depending on the fibers, the treatment may be effected by wet saturated steam at 99°—101°C, or by dry saturated steam at 101°—106°C, and finally by superheated steam, the whole at atmospheric pressure.

It is another object of the invention to provide a method enabling the carrying out of combined bulkiness, shrinkage, crinkliness and relaxation treatment in fabrics of synthetic, natural or mixed fibers through a scouring and bleaching process.

A further object of the invention is to provide a method enabling the carrying out, as a last operation, of a returning treatment of the initial fabric characteristics, such as crinkliness or bulkiness, after printing or dyeing, so as to obtain simultaneously the "crepe de chine" effect and dimensional stability of the fabric.

According to the present invention, there is provided a process for treatment of fabric by steaming, comprising steps of feeding a fabric web at a first rate to a steam saturated downwardly open chamber, holding the fabric in said chamber for a predetermined time with the fabric in an untensioned condition, removing the fabric from the steam chamber at a second rate, lower than said first rate, and controlling the degree of fabric shrinkage during the treatment by maintaining at a substantially constant value the amount of fabric within said steam chamber.

The invention further provides an apparatus, for carrying out the above process, comprising at least one downwardly open steam chamber with passages for supplying steam to the top of the chamber, and means for feeding fabric web under untensioned condition, said means comprising at least one pair of electrically driven rollers, of which a first feeding roller for winding the fabric thereon is rotatable at a first speed and a second removing roller for winding the fabric thereon from a loop formed between said first and second rollers is rotatable at a speed lower than the first speed, a device for controlling

the amount of fabric in the steam chamber being operatively connected with the circuit of the electric drive for one of said powered rollers.

By the process according to the invention, it would be also possible to combine preparatory or additional fabric treatments, with e.g. bulkiness, crinkliness, or shrinkage treatments, and other processes, such as fabric bleaching and scouring processes, by providing washing elements before and/or after steaming.

Thus, complete removal of oils and chemicals used in yarn or thread preparation and weaving is ensured. These products are emulsified, oxidized, volatilized in the wet-hot steam ambient and therefore readily removed in the subsequent washing tanks.

From the foregoing, it would be possible to combine a process line comprising one or more washing tanks, steaming and then two or more washing tanks.

Prior to steaming, the fabric in the tanks is impregnated with water and then washed with detergents having the purpose of removing oils and other products used in weaving. The fabric is then passed to steaming and, issuing therefrom, enters further tanks where, in addition to complete removal of said products used in weaving, it is possible to obtain, for example, with other chemicals varying from one fiber to another, blueing or optical bleaching of the fabric.

During steaming, fiber swelling occurs, which promotes penetration of bleaching products. Said blueing operation can be also effected in tanks located upstream of steaming. Finally, the fabric is rinsed in the last washing elements ready to be dried.

The invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal sectional view showing a first embodiment of the apparatus according to the invention;

Figure 2 is a transverse sectional view of the apparatus shown in Figure 1;

Figure 3 is a view similar to that of Figure 1, but showing a modified apparatus; and

Figure 4 shows an arrangement for the combination of bulkiness treatments with bleaching and scouring treatments.

In Figures 1 and 2 of the accompanying drawings a first embodiment is shown of an apparatus for continuous treatment of a fabric.

The apparatus comprises a steam chamber 1, downwardly open and defined by side walls and top wall 3 lined with heat insulating material.

Steam passages 4 and 5 are formed along the side walls 2 and top wall 3 respectively. As shown in Figure 2, a quantity of water 6 is provided on the bottom of the passages 4 in the side walls 2. The water 6 is heated and brought to boiling for steam generation, this steam moving upwards along the passages 4, passing through apertures 7 communicating with the passage 5 of the chamber top wall 3, and then through central apertures 8 in the inner wall of the passage 5 to enter the steam chamber 1. The steam then moves downwards, where it is drawn through a suction manifold 9 located internally and along the lower edge of the chamber 1. Said manifold 9 is connected through a pipe 10 and a steam suction fan 11 to a stack 11'.

Water 6 on the bottom of the side passages 4 can be heated by any suitable means, such as by steam circulation within a pipe 12 immersed in the water or, according to requirements, by electric resistances or diathermic oil coils. If desired, the steam could also be supplied under pressure and at a predetermined temperature from a suitable heating plant located separately from the apparatus. The steam being produced should be at the proper temperature for the desired process and depending on the fibers to be processed, for example, at 100°C, 1 abs. atm. wet saturated for acrylic fabric, at 104°C, 1 abs. atm. dry saturated for nylon fabric, and at 140°C, 1 abs. atm. superheated for polyester or polyamide fabric. Steam superheating could be effected, for example, externally of the apparatus by a circular coil heater operating with a gas, fuel oil or gas oil burner, or within the passages 4 by diathermic oil coils (not shown).

Within said steam chamber 1 and at the top or adjacent the ceiling, there are provided a feeding roller 13 and a withdrawing roller 14, both of which are rotatably supported by the side walls on horizontal shafts 15. Roller 13 is driven through a drive 16 by a first electric motor 16 located externally of the chamber, and roller 14 is driven through a drive 17 by a second electric motor 18.

Rollers 13 and 14 for introducing and removing fabric web 19, which is to be steamed, are rotatably driven at different speeds to each other to compensate for fabric shrinkages, as will be further explained below. Correlation of rotational speeds of the rollers 13 and 14 can be provided by any known means, for example by an electrical and/or mechanical interlocking.

As shown by the arrows in Figure 1, fabric 19 is fed into the bottom of the steam chamber 1 after passing around idler rollers 20, and drawn up by the roller 13. The fabric 19 then forms a free hanging loop 21, and is drawn upward by the roller 14, whereafter the fabric issues from the bottom of steam chamber 1, passing around idler rollers 22.

The travel length of fabric within the chamber and the speed of rotation of the rollers 13 and 14 should be such as to retain the fabric within the chamber for a preset time, for example from 10 to 100 seconds, sufficient to perform the desired steaming process. Such times are considerably shorter than

the processing times required when treating in water or air.

Steaming should take place without any tension on the fabric, so that the fibers of the fabric are allowed to take advantage of the shrinking effect imparted by the wet and hot atmosphere of the steam chamber.

Therefore, the chamber should be maintained at uniform temperature and moisture content to ensure a similar effect throughout the fabric length and width. For example, this is provided for by the downwardly open configuration of steam chamber 1, with steam supply from the top. To this end, a detector device has been placed at the bottom of fabric loop 21 to allow for a constant uniform fabric treatment and constantly controlling the shrinkage thereof within steam chamber 1, this detector device comprising photoelectric sensors 23, 24, monitoring the position of the bottom of the fabric loop 21. For example, the sensors 23, 24 may be connected to a potentiometer in the power circuit of motor 16 or 18 to vary the introduction or removal rate of the fabric web 19, so that a constant amount of fabric is maintained in the processing chamber 1. Instead of a photoelectric device, any other electrical or mechanical device, capable of controlling any excess or reduction in the fabric shrinkage during the process and accordingly controlling the fabric introduction and/or removal rate, could be used.

In the apparatus shown in Figure 1 and Figure 2, the process can occur in saturated or superheated steam depending on requirements, that is with steam temperature ranging from about 100°C to about 160°C. However, as previously mentioned, it may be sometimes convenient subsequently to combine the saturated steam process step or a dry steam step, with the superheated steam step.

An apparatus for performing such a process is schematically shown in Figure 3 of the accompanying drawings, and comprises a first chamber 25 for saturated steam and a second chamber 26 for superheated steam. Said chambers are separated by a partition 27 having a horizontal slit 28 formed therein for the passage of fabric 29.

As in the chamber 1 in Figures 1 and 2, outer walls 30 of bell chambers 25 and 26 are formed with passages 31 and 32 for saturated steam supply and superheated steam supply respectively through aperture 33 and 34 formed in the top walls of the steam chambers. Steam in chamber 26 can be superheated as previously described. A steam suction manifold 35 is placed internally and at the open lower end of said steam chambers. Such a manifold is in communication through a pipe 36 with a suction fan 37 conveying the steam to a stack 38. For a proper heat insulation, a layer 39 of heat insulating material is located externally of the side walls and top wall of the chambers.

Fabric web 29, as fed from the bottom into the pretreatment or saturated steam chamber 25, moves under relaxed condition, i.e. clear of any tension, along the top run of a sloping continuous conveyor 40, located internally of saturated steam chamber 25, to better supply the fabric to roller 41, particularly for heavy or slippery fabrics. However, the fabric could also be fed vertically.

From conveyor 40 said fabric web 29 passes through the slit 28 of partition 27 into chamber 26, then winds up on roller 41 for introduction into the superheated steam chamber 26 to form one or more free hanging loops 42. The fabric is then wound upward on a removal roller 43 and issues at the bottom of chamber 26.

Conveyor 40 and fabric introduction roller 41 are powered and controlled by an electric motor 44 and drives 45 and 46. Similarly, removal roller 43 is powered by an electric motor 47 and drive 48. As in the embodiment shown in Figures 1 and 2 photocells 49, 50 for controlling the length of fabric loop are provided in the chamber 26.

The fabric 29 fed from the bottom to chamber 25 is arranged under substantially untensioned condition on conveyor 40, where it undergoes a pretreatment, being subjected to the action of the saturated steam in said chamber 25. The fabric then passes to the superheated steam chamber where, as previously mentioned, the fabric is relaxed and its fibers may be penetrated by chemicals.

In the embodiments shown in Figures 1 to 3, the possibility is thus provided of combining steaming, for instance for performing bulkiness, creping, relaxation and shrinkage fabric treatments, with bleaching and scouring treatments. This can be illustrated by referring to arrangement shown in Figure 4.

In Figure 4, fabric 100 is first immersed in a tank 101 for impregnating the fabric with water, then passed to a tank 102 containing washing products, such as a solution for deterging oils and residual products from loom processing. The fabric is then caused to pass through a steaming chamber 103, as in the previously described cases.

On issuing from steaming chamber 103, the fabric is immersed in a tank 104 containing chemicals for fabric bleaching or blueing, this operation being followed by a rinsing stage in tank 105. If desired, the bleaching step could be carried out upstream of steaming, and after fabric scouring. Thus, the complete removal of oils and chemicals used in yarn and weaving preparation is ensured. These chemicals are emulsified, volatilised in the wet-hot steam, and then readily removed in the subsequent washing stages downstream of the steaming apparatus.

The advantages of a process according to

the present invention can be better understood from the results of the following comparative tests.

Tests have been carried out with fabric samples treated in hot water at a temperature of 85°—95°C, and then in cold water at a temperature of 10°—20°C. Said tests have been carried out with fabric under untensioned condition and immersed in water tanks.

A hot air test has been carried out on a normal hanging loop drier at a temperature of 140°—160°C.

Finally, tests were carried out with fabric treated with wet saturated steam at 100°C.

The treated fabric in each case was made of synthetic fibers.

The results of the tests are shown in the following table:

TABLE

| Processing | Insertions | Width | Warp Number (Threads) |
|---|---|---|---|
| Blank | 35 | 160 | 39 |
| Cold Water 10 min. | 36 | 156 | 41 |
| Hot Water 10 min. | 40 | 141 | 45 |
| Saturated steam 1 min. | 40 | 146 | 45 |
| Hot air 15 min. | 35 | 158 | 40 |

As shown by the above table, the new fabric steaming process ensures a higher swelling (bulkiness) of the fibers over the treatments with water and air. Thus, the fabric width is about 3% higher in steaming at the same number of threads and insertions. Of course, this is due to the larger volume taken by the thread after steaming.

Further, the fabric appearance after steaming has enhanced the "orange skin" appearance, technically referred to as "crepe de chine", commercially emphasizing synthetic fabrics by rendering them similar to silk fabrics. From the samples it is observed that said "crepe de chine" appearance is about 50% higher in steamed fabrics than water or air processed fabrics.

Finally, on tactile examination, a softness and bodiness is found in steamed samples which is at least 40% higher than that of samples treated with hot water, and 70—80% higher than that of fabrics treated with hot air or cold water. Steaming times were about 10 times less than those of treatments with cold or hot water, and about 15 times less than hot air treatment.

WHAT WE CLAIM IS:—

1. A process for treatment of fabric by steaming comprising steps of feeding a fabric web at a first rate to a steam saturated downwardly open chamber, holding the fabric in said chamber for a predetermined time with the fabric in an untensioned condition, removing the fabric from the steam chamber at a second rate, lower than said first rate, and controlling the degree of fabric shrinkage during the treatment by maintaining at a substantially constant value the amount of fabric within said steam chamber.

2. A process according to Claim 1, wherein the fabric is immersed in wet saturated steam.

3. A process according to Claim 1, wherein the fabric is immersed in dry saturated steam.

4. A process according to Claim 1, wherein the fabric is immersed in superheated steam.

5. A process according to Claim 1, wherein the fabric is first immersed in wet or dry steam, and then in superheated steam.

6. A process according to any preceding Claim, wherein upstream of the steaming step, a scouring step and a bleaching step for the fabric are carried out.

7. A process according to any of Claims 1 to 5, wherein upstream of the steaming step a scouring step is carried out, whereas downstream a bleaching step is subsequently carried out.

8. A process according to any preceding Claim, wherein the fabric shrinkage rate is controlled by adjusting the fabric web introduction rate.

9. A process according to any of Claims 1 to 7, wherein the fabric shrinkage rate is controlled by adjusting the fabric web removal rate.

10. A process according to any preceding Claim, wherein the fabric is held in the steam chamber for a time ranging from 10 to 100 seconds.

11. An apparatus for carrying out the process according to any of the preceding Claims, comprising at least one downwardly open steam chamber with passages for supplying steam to the top of the chamber, and means for feeding fabric web under untensioned condition, said means comprising at least one pair of electrically driven rollers, of which a first feeding roller, for winding the fabric thereon, is rotatable at a first speed and a second removing roller, for winding the fabric thereon from a loop formed between said first and second rollers is rotatable at a speed lower than the first speed, a device for controlling the amount of fabric in the steam chamber being operatively connected with the circuit of the electric drive for one of said powered rollers.

12. An apparatus according to Claim 11, further comprising a second downwardly open

steam chamber communicating with the first chamber through a fabric passage aperture, a continuous conveyor in said second chamber being provided for feeding the fabric through said chamber.

13. A process for treatment of fabric by steaming substantially as herein described with reference to the accompanying drawings.

14. An apparatus for treatment of fabric by steaming substantially as herein described with reference to the accompanying drawings.

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1507633 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

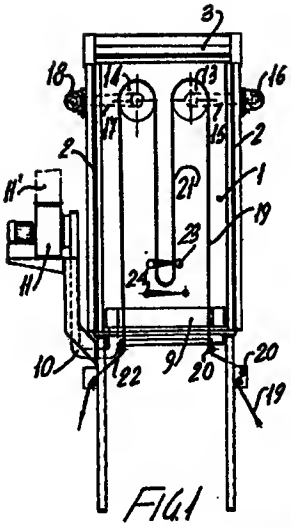

FIG.1

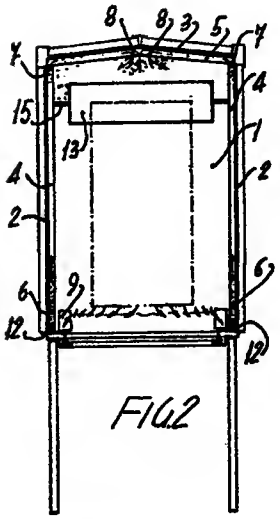

FIG.2

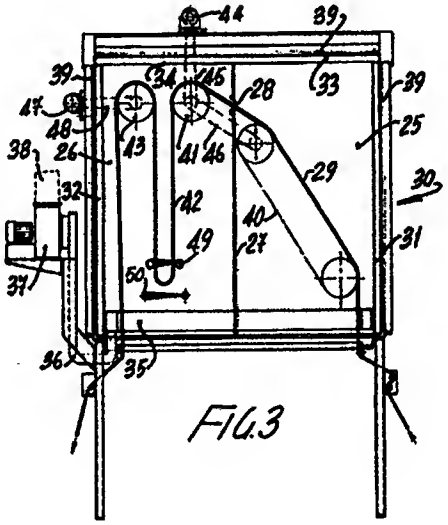

FIG.3

1507633 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

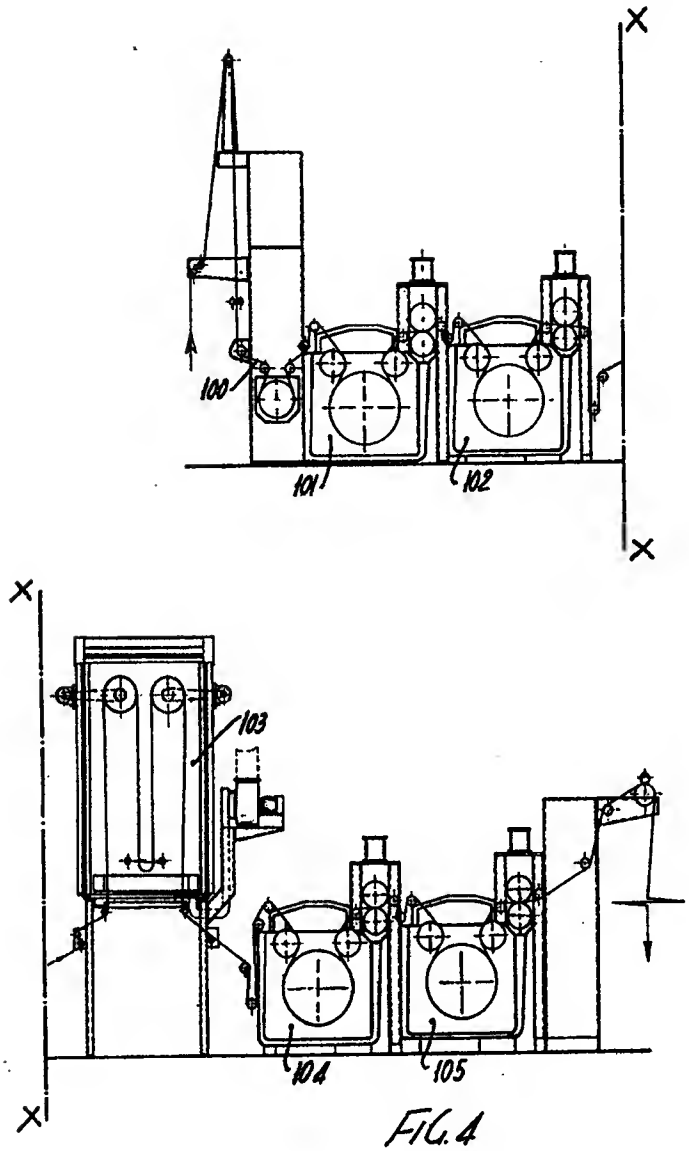


FIG. 4